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ABSTRACT

This review of the research on concerns associated with the use of computers in school learning environments focuses primarily on issues related to the impact of computer technology on equity, especially the reasons for differential use of computers by boys and girls and the effects of economic disparities among schools and students; differences in philosophy of school management; differential use of computers by students with different cognitive ability (especially as related to the learning condition of locus of control); location of computers in schools; and the practice of using computers as a reinforcement for academic behavior. The effects of computer use on the social patterns of students, motivation, and the role and attitudes of teachers are also discussed. It is suggested that further research is needed to consider the effects of computer-student ratios, location and arrangement of computer-based learning environments, the design features of instructional hardware and software, and inservice teacher training models used to facilitate the implementation of the technology. It is pointed out that both qualitative and quantitative research designs are needed to provide information about the processes related to the use of computers in the learning environments and the immediate effects of computer-based learning on students. A list of references is provided. (JB)

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RESEARCH ISSUES IN COMPUTER-ASSISTED LEARNING ENVIRONMENTS

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Abstract

This paper addresses concerns associated with the use of computers in school learning environments. Issues related to the impact of computer technology on equity, social patterns of students, motivation, and the role of the teacher are discussed. It is proposed that further research consider the effects of computer-student ratios, location and arrangement of computer-based learning environments, the design features of instructional hardware and software, and inservice teacher training models used to facilitate the implementation of the technology. Future research activities are needed to guide the development and use of computer-based learning environments.

Some consider the invention of electronic media to be the fourth great revolution in human education. Eric Ashby, a British education technologist describes the four major revolutions to be: the formation of schools, the use of the written medium, the invention of books, and the invention of electronic media (Bork, 1981). There is little doubt that computer technology has had and will continue to have an impact on learning environments at all levels of education. Over the past five years, there has been a widespread adoption of microcomputers by institutions of learning. Recent surveys indicate that more than half the schools in the United States have a microcomputer (Becker, 1983), and at this time an even higher percentage can be estimated. Unfortunately, microcomputer hardware and software have been introduced into the schools with little regard for the impact of the technology on the cognitive development of students, the social context of the classroom, or the role of the teacher.

Equity Issues

An important issue related to social context is that of equity. Research indicates that there is disparate use of the computer by students of different gender, economic status, and cognitive ability. Equitable use of computers is a complex issue with no simple remedy. Although it is evident differential use of computers occurs, causal relationships are not clear.

With respect to gender differences there is a higher frequency of computer use among males than females (Sheingold, 1981; Lockheed, Nielsen, & Stone, 1984). Males report more use of computers and enroll more frequently in computer programming courses (Sheingold, 1981).

Although girls acknowledge the need for computer skills in the future, they do not participate as frequently in computer activities (Lockheed, Nielsen, & Stone, 1984). Evidence to this effect can be found in school programs at all age levels (Sheingold, 1981).

Moreover, a survey completed by the directors of summer computer camps indicates more boys than girls go to computer camps. The survey also revealed that female enrollment declines as the difficulty of the computer curriculum increases and as the camp becomes more expensive (Miura & Hess, 1984). Parents seem more willing to invest in computers and related materials for their sons than for their daughters (Lockheed & Frakt, 1984). Explanations for this circumstance range from parents' belief that it is more worthwhile to make the expenditure for boys than for girls to the premise that the activities are unappealing to girls. If the latter is the case, further research may help to identify elements of computer activities and computer-based environments that potentially may appeal to females. In any event, it is important to recognize the strength and effects of parental influence in this issue.

Current research provides some evidence of the presence of a gender difference in preference for kinds of software and computer activities. In a study of the preferences of pre-school children for types of software, it was observed that girls preferred software of the drill and practice type, whereas boys preferred creative problem solving programs (Swigger, Campbell, & Swigger, 1983). Girls also report they have a greater interest in application programs like wordprocessing, whereas boys state they would rather develop further programming skills (Lockheed & Frakt, 1984). Attempts to identify and isolate the motivational features of educational computer games have also been made

(Malone, 1981; Lepper, 1985). It appears that software with a verbal orientation is more appealing to girls while software that provides an aggressive environment with objects projected through space appeals to boys. This finding is congruent with the results of a study of sex differences in children's game preferences which revealed that boys liked games that involved throwing objects and girls did not (Rosenberg & Sutton-Smith, 1960). There is also evidence that boys are more aggressive than girls (Bandura & Walters, 1964; Maccoby & Jacklin, 1974). Further research should be conducted to identify the efficacy of extrinsic and intrinsic motivation features used in computer-based activities for students of different gender.

The current status of differential use of computers by students of different gender may result in a greater economic disparity between the sexes. Based on current trends, boys develop skills that probably will result in higher paying positions later on, while girls develop clerical skills destined to keep them in low paying jobs. There is a need for a better understanding of the impact of specific design features and the environment in which computer activities occur and their relationship to preference by students of different gender. The information derived from this research should be used to guide the development of future systems and provide information to the selectors of instructional software. This line of inquiry has important implications for the use of computers in the classroom environment. By these means, hardware and software with features that would be motivational to students of both sexes could be designed and selected for use in schools.

Economic disparities among schools and students also account for differences in computer use by students. Surveys indicate wealthier

schools are more likely to have computers (Becker, 1984; Anderson, Welch, & Harris, 1984). In addition, there are differences in the way computers are used in schools with different economic bases. Students in wealthier schools are more likely to learn to program a computer, whereas students in poorer schools are more likely to receive remediation in basic skills delivered by a computer (Anderson, Welch & Harris, 1984). As would be expected, individual level of economic status has some bearing on whether or not a student has access to a computer outside of school. Students from middle and upper income homes are more likely to own a computer and attend computer camps and summer computer classes (Miura & Hess, 1984). The disparity between school districts and students of different economic level will probably be widened by the current dispersion and use of computers within schools.

Becker (1983) examined differences between low socioeconomic status (SES) schools that are predominantly white with those that are predominantly a minority school. Different patterns of computer use among these two groups of schools exists. Minority schools use drill and practice software more than programming activities with their students, whereas the low SES predominantly white schools report higher use of programming with their students. However, further analysis of the data indicates a more significant difference between the two groups. The low SES white schools report more computer use by above average students, whereas the minority schools report more computer use by their below average students.

This trend reflects a difference in philosophy about the management of the learning environment for students. Some schools believe intensive drill and practice in remedial skills is most beneficial to

their students. In contrast, the predominantly white schools believe it is more important for the teacher to spend time with the low achieving students. In these schools the above average students use the computer. Learning to program the computer is viewed by the school as an activity that will challenge the student and keep him engaged in the learning environment. Future research should examine the effect of different computer learning environments on student achievement.

The differential use of computer technology by students with different cognitive ability is another instance of inequity. It is generally true that students who are high achievers, especially those who are good in math, are more likely to receive instruction in programming and problem solving activities. Low achievers receive computer-assisted instruction in the form of drill and practice for the purpose of remediation (Sheingold, 1981). Some educators postulate that the development of programming skills results in higher level problem solving skills that will increase students' ability to solve problems in other settings (Bell, 1978; Howe & Duboulay, 1979; Lipson, 1980; Leuhrmann, 1980; Papert, 1980).

A learning condition related to differential use of computers is locus of control. When students are involved in learning to program computers the students are in control. They operate in "solo mode" (Dwyer, 1980) with the raw power of the computer at their fingertips. Programming a computer is a learning environment that allows students to pose hypotheses, plan, create, and debug or locate errors. Conversely, when students receive drill and practice lessons delivered by the computer, the computer is in control. Students are involved in convergent thinking and are required to produce the correct answer to

each question. If the processes and effects of these two computer environments are really different, then further intellectual differences will be created between students of different gender, economic status, and cognitive ability. Research should be undertaken to determine the relationship between experience programming computers and achievement in academics as well as opportunities in later life. Another interesting line of inquiry would be to investigate the interaction between student cognitive style and student success and comfort with the locus of control in the computer learning environment.

Given the previous information, it is obvious inequitable use of computers exists within schools. Factors within the control of the school and individual teachers may have some bearing on this issue. One variable that appears to affect the equitable use of computers is the location of computers within the school (Becker, 1983). When microcomputers are located in individual classrooms, there is more equity in computer use between below-average and above-average students. Location of microcomputers in a computer lab results in heavy use of the computer for programming by boys and high achievers. However, computers are placed outside classrooms in computer labs or media centers in almost half of computer-owning schools (Becker, 1984). Educators should make decisions about the location of computers within their schools with consideration to the effect location may have.

Another variable affecting equitable use of computers is the practice of using computers as a reinforcement for academic behavior. Some teachers use time on the computer as a reinforcement for completion of assignments or good behavior (MacGregor, 1984). Teachers using this

technique are utilizing the Premack principle (1965) in that they make a high frequency behavior (computer usage) contingent on a low frequency behavior (class assignments) to strengthen the low frequency behavior. This approach is effective for students who value the use of the computer. However, there are some potential problems associated with this practice. Teachers need to consider the effect of use of the computer as a reinforcer on all students. Since girls appear to be less interested in the computer, it may not be an effective reinforcer for the desired behavior. Use of the computer in this way may also contribute to greater inequity in computer usage among girls and boys.

In addition, less able students do not fare as well as more able students in earning time to use the computer. Even though computer use may be a valued activity, less able students frequently do not finish their assignments as quickly as more able students. When there is only one computer in a classroom, or limited computer time available, the less able student may not work quickly enough to attain the valued activity. This is unfortunate in light of research which investigated the effect of systematic use of computer-assisted instruction by less able students (Griswold, 1984). Below average students in the fourth through sixth grade who used computer-assisted instruction for a two year period exhibited greater academic self confidence. This was manifested by the students' views that they had greater control over their learning. It is evident that researchers should investigate the positive and negative effects which result from various classroom practices of computer use. It is also obvious that additional research focused on the identification of variables within the learning environment that affect equitable use of the computer is needed.

Social Organization

The presence of computers in classrooms may have an impact on the social organization of students in the class. A primary concern of teachers is that computer-based learning can be isolating and have negative effects on interpersonal social skills of students (Lichtman, 1979). Some research indicates that this is not a result of computers used in the classroom. It has been observed that pre-school children prefer to use the computer with others and like to share their experiences with friends and adults (Swigger, Campbell, & Swigger, 1983). Observations of elementary school settings with an abundance of computer equipment and activities designed for individuals indicated the predominant social arrangement was groups of children gathered around a single computer working together at a computer-related task (Levin, 1981; Becker, 1984). Additionally, students who used a word processing program to write compositions interacted more with other students than students who used the traditional approach to write compositions (Tolbert, 1985). It appears that students do not become isolates when they are participants in a computer-based learning environment.

The introduction of a computer or several computers into the classroom has some observable effects on social arrangement (Becker, 1984). When teachers have more students than computers the learning environment must be reorganized to accommodate computer use. The predominant activity for students not involved in computer use is seatwork, and whole class lecture and discussion are avoided while the computer is in use. It appears that more experienced teachers organize students not using the computer into small groups to work on projects, whereas less experienced teachers let students watch the computer using

students or assign seatwork. Another social organization pattern is whether students work at the computher independently or in pairs or small groups. Women teachers and teachers with an arts-and-science background are more likely to pair students at the computer. Men and education majors have students work independently at the computer (Becker, 1984). Research should examine the differences between classes with and without computers to determine if the presence of computers has an effect on the classroom learning context. The effect of collaborative learning at the computer for different grade levels and content areas should also be investigated.

Evidence indicates the computer does not seem to disrupt pre-defined social groups in the class, and reinforces established leaders within the group. However, an interesting observation is that computers in the classroom appear to create new leaders based upon individuals who have knowledge of the operation of the computer (Swigger & Swigger, 1984). Further research should be undertaken to observe the effects of specific classroom organization of computers and computer activities on social interaction patterns.

Role of the Teacher

Not only do computers directly affect students, but the technology has an impact on the role of the teacher as well. Teachers frequently express concern about the impending change in their role when computers are introduced into their classroom. Additional demands are made on teachers in that they have to learn how to use a new technology as well as instruct students in the use of computer hardware and software. Teachers are faced with decisions related to how and when to use the computer. Computer time for students must be scheduled, computer activities assigned, and records of student use of software kept. In

addition, the use of networking and information retrieval from remote data bases will add to the repertoire of teaching methods with which teachers must be familiar. The impact of the imformation age may change the role of the teacher from one of disseminating knowledge to one of motivating, advising, and managing the student's learning (Reigeluth, 1983).

Use of the computer in the curriculum has tremendous implications for learning with the impending shortage of teachers. It may be necessary to rely on the use of computer-assisted instruction as an adjunct to teacher-based instruction. Research findings indicate computer-assisted instruction is at least as effective as traditional methods of instruction (Alderman, 1978; Kearsley, 1977; Magidson, 1978; Murphy & Appel, 1977; Paden, Dalgaard & Barr, 1977; Splittgerber, 1979). There also appears to be a mesh between the areas of greatest teacher shortage and the content areas for which computer-assisted instruction is most effective. Teachers of math and science are in greatest demand, and computer-assisted instruction is more effective for the content areas of science and math than for language arts (Ballas, 1982; Forman, 1982; Fisher, 1983). It may become essential for schools to utilize technology to create effective and efficient learning environments.

Presently there are a number of different approaches to inservice training and implementation models used to assist teachers in integrating the technology into the curriculum. However, there is no long history with prototypes of tested models which make it easy for a school system to select the best plan for its particular situation (Cory, 1983). Although the technology is ahead of teacher training, an effort to identify and implement new models of pre- and in-service training is required.

At this point in time, there does not seem to be a consensus regarding competencies or attitudes needed by teachers for effective classroom computer implementation (Bruwelheide, 1982). Therefore, it has not been possible to provide teachers with an operational definition for successful classroom computing. To add to the complexity of the issue, there are several educational applications for computers in the classroom from which teachers can choose. Teachers may use the computer as a medium for delivery of instruction, as an electronic tool for themselves and their students, as an object of instruction, and as a reinforcement for various classroom behaviors. Different kinds of competencies and perceptions of computers are required for use of each application.

Teachers' preceptions and use of the computer in the classroom may be affected by the model of inservice training used. The way teachers perceive their role as a selector of courseware, manager of computer-assisted learning environments, and facilitator of equitable student learning may be affected by the computer literacy training they received. Moreover, the application selected by the teacher may impact the social context of the classroom, equity of use, and the psychological and cognitive development of students. Identification of teacher perceptions, factors influencing these perceptions, and the relationship of perceptions to the organization of the computer-assisted learning environment is important. Future researchers should investigate the relationships between the aforementioned factors. Investigations of the effects of the various models used by schools to implement the innovation and the definitions of computer literacy upon which they are based would provide educators with important information related to the implementation of computer-based learning environments.

Summary

To summarize, it is evident that although computers have been adopted in many classrooms already, there is an extensive research agenda for researchers interested in these issues. Further research activities are needed to identify and improve the way computers affect the learning process and the social context of the classroom. Future researchers should consider the effects of computer-student ratios, location and arrangement of computers, the design features of instructional software and hardware, and the inservice models used to facilitate the implementation of the technology. This information is needed so that teachers and administrators can make decisions about the purpose for which computers are to be used, the selection of appropriate and quality software, the location and arrangement of computers within schools, and the selection of in-service models of training. It is also evident that both qualitative and quantitative research designs are needed to provide information about the processes related to the use of computers in the learning environments and about the immediate effects of computer-based learning on students. Further qualitative and quantitative research of the issues discussed will contribute to the development of an unbiased and representative body of information about how computer-assisted learning environments affect both the cognitive and social processes in the classroom.

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